PSW FOREST AND RANGE
EXPERIMENT STATION
AUG 4 1971
STATION LIBRARY COPY

THE HELIJUMP -- The Research and Development of the Helicopter Hover Jump Technique.

by James L. Murphy

FOREST SERVICE - U.S. DEPARTMENT OF AGRICULTURE

PACIFIC SOUTHWEST
FOREST AND RANGE
EXPERIMENT STATION

BERKELEY, CALIFORNIA

MISCELLANEOUS PAPER NO. 32 — APRIL 1959

THE HELIJUMP--THE RESEARCH AND DEVELOPMENT OF THE HELICOPTER HOVER-JUMP TECHNIQUE

By James L. Murphy [1/]

Miscellaneous Paper No. 32

April 1959

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION

1/ Formerly on the staff of the Division of Forest Fire Research, Pacific Southwest Forest and Range Experiment Station; present address: Payette National Forest, Council Ranger District, Council, Idaho.

The work upon which this report is based was performed under terms of a cooperative agreement between Utah State University and the Pacific Southwest Forest and Range Experiment Station, formerly known as the California Forest and Range Experiment Station.

CONTENTS

	Page
DEVELOPMENT OF THE HELIJUMP TECHNIQUE . .	2
Helijump Guidelines--the 1958 Test Program . .	4
Test Objectives	4
Test Procedure	5
Results and Conclusions	8
The Helijump Suit	8
Flying Speeds	9
Cover Types	10
Open Ground	12
Slopes	12
The Helijump Procedure	13
RECOMMENDATIONS	14
The Helijump Suit	14
The Helijump--Picking the Jump Spot	14
The Four-pass Helijump Technique	15
High Level Reconnaissance Pass	15
Low Level Reconnaissance Pass	15
Tool Drop Pass	15
Jump Pass	16
SUMMARY--THE HELIJUMP TECHNIQUE PICTURED.	17
BIBLIOGRAPHY	22

THE HELIJUMP--THE RESEARCH AND DEVELOPMENT OF THE HELICOPTER HOVER-JUMP TECHNIQUE

By James L. Murphy

"The fire's only a spot--I could catch it if I could hit it in the next few minutes--but this helicopter can't land in that brush." This kind of predicament faced many firemen in the early days of helicopter fire reconnaissance (1), when a crew hiking into the fire usually couldn't hope to reach it for hours. Soon the helicopter-firemen started thinking about jumping--"if the helicopter can hover a few feet off the ground, I'll just step out on the skid and jump." Many of these hover-jumps were actually done (1, 2), but the firemen were flirting with serious injury. In 1949, the Forest Service tightened down on its helicopter operating policy--no jumping was the order (3).

By 1953, the helicopter as a forest fire-fighting tool was definitely "in". However, it would be years before adequate helispot coverage could be developed in inaccessible country. There was a definite place for the hover-jump in helicopter operations if the jump could be done safely. This required a proved jump technique, a protective suit, and trained personnel and pilots. A "Helishot" 2/ crew organized on the Angeles National Forest in 1954 (4) showed that safe hover-jumping by a team of helicopter specialists could be done.

In 1955 Project Helitack 3/ was begun. The main objective of Helitack was the integration of helicopters into forest fire suppression (5). Helitack included as one of its specific objectives the organization and training of "Helitack crews," or crews of helicopter specialists. The work included development of safe guidelines for the helicopter hover-jump, or "helijump".

2/ Helishot: "helicopter hot-shot".

3/ Helitack is a cooperative research and development program between the U. S. Forest Service, the U. S. Army, and the California Division of Forestry.

DEVELOPMENT OF THE HELIJUMP TECHNIQUE

In 1954 and again in 1956 Helitack crews on the Angeles National Forest worked with contract helicopter pilots and developed a preliminary helijump technique (4, 6, 7). But more intensive studies were necessary before specific guidelines could be set up. Also, a coverall-type protective suit was developed in 1954 by the Angeles Forest Helitack crew (4, 7). Use of the suit showed it had many limitations. The expert guidance of the Missoula Aerial Equipment Development Center was enlisted to help solve the many technical problems of protective garment design and manufacture, resulting in a revised suit in early 1958.

A coverall-type helijump protective suit was developed in 1954 by the Angeles forest Helitack crew.

The guidance of the Missoula Aerial Equipment Development Center was enlisted to help develop and manufacture the 1958 model helijump suit.

By early summer, 1957, the preliminary helijump technique and the protective suit were ready for field testing. Forest Service Safety Officer Seth Jackson reviewed the Helitack crew program in June of that year. The recommendations that he made set the pattern for future Helitack developments. Mr. Jackson's recommendations were:

1. That crew training would be necessary to safely orient field personnel in Helitack techniques. The 1957 Helitack crew training program included 300 fire fighters from 13 national forests, the California Division of Forestry, and the Los Angeles County Fire Department (8, 9).

2. That a research program to determine specific helijump guidelines with respect to jump heights, helicopter speeds, cover types and slopes would be advisable. He suggested that movable dummies be used for the tests.

The helijump tests were scheduled for early 1958. Test results were to be included in the 1958 Helitack crew training program.

Helijump Guidelines--the 1958 Test Program

The Chilao Flats area of the Angeles National Forest, California, was chosen for the helijump tests. The test area was at an elevation of 5,300 feet. The density altitude 4/ on the days tests were conducted was 7,500 feet, a condition representative of many western forest areas. Chilao Flats offered a wide variety of cover types and topographical variations within the test area. The prevailing southwest wind varied from 5 to 10 miles per hour during the tests. The Los Angeles County Fire Department furnished their training officer, chief pilot, and a Bell G-2 helicopter for the tests. The College of Engineering, University of California, at Los Angeles, loaned the Forest Service two electronic dummies used in their collision injury research program. The Angeles National Forest's Chilao Helitack crew provided technical advice and assistance.

Test Objectives

A preliminary examination of the test procedures and their possible implications indicated that more than just helijump

---

4/ Density altitude is pressure altitude corrected for temperature.

guidelines might be expected from the tests. The final aims of the helijump tests were:

1. To test the safety features of the current helijump protective suit under various conditions of cover type and terrain.

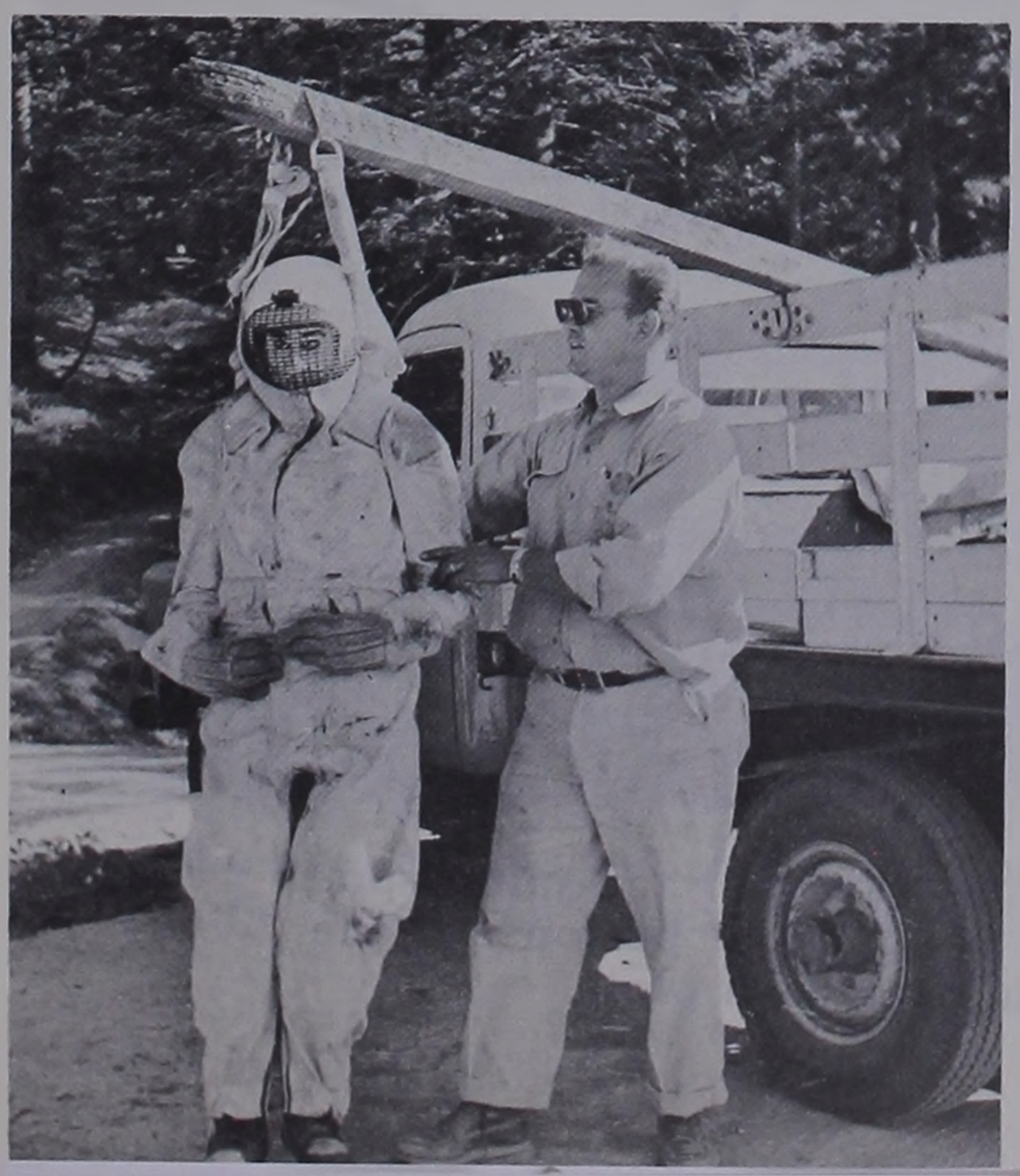
2. To establish guidelines for a safe helijump with respect to:

a. Helicopter flying speeds
b. Jump heights, from helicopter to ground
c. Cover types
d. Terrain
e. Slopes

3. To determine whether test results would indicate any necessary changes in the helijump technique.

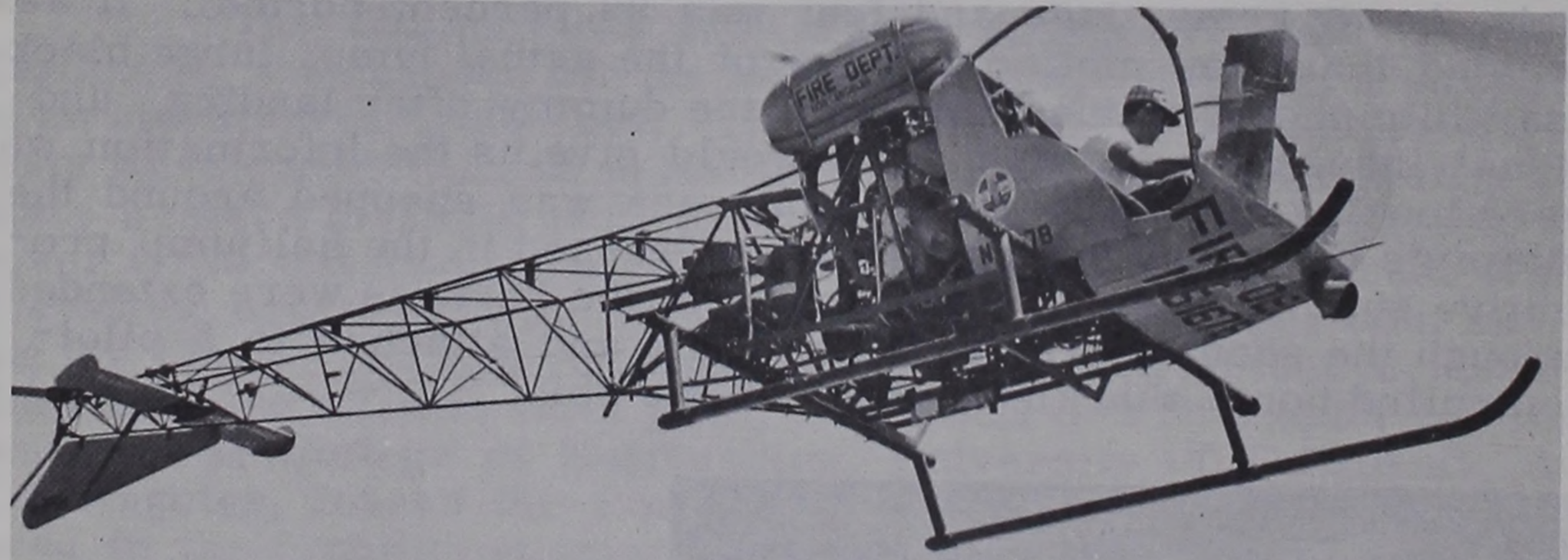
Test Procedure

The movable dummy chosen for the tests was a 175 pound, 5 foot 10 inch "95 Profile" mannequin. UCLA engineers explained that "95 Profile" meant that the movement of the dummy's body, head, arms, legs and feet was 95 percent normal. It was decided that slow motion movies of the actual jump, large black and white photos of the position of the dummy after landing, and visual inspection of each jump would give us the information we were looking for. A parachute harness was snapped around the dummy's body and the dummy was dressed in the helijump protective suit. The suspension straps of the harness were extended through the shoulders of the jump suit and attached to a pilot-controlled bomb shackle underneath the ship.



A 175 pound, 5-foot 10-inch dummy whose movements were 95 percent normal was dressed in the helijump protective suit for the tests.

The dummy was suspended from a pilot-controlled bomb shackle underneath the ship.



When the helicopter was over the jump spot, the pilot pressed the release button and the dummy dropped into the test plot.

The dummy was placed in the position a crewman should take after stepping off the helicopter skid during the helijump procedure. When the helicopter was over the jump spot, the pilot pressed the release button, and the dummy dropped into the test plot.

Twenty test plots were chosen in the experimental area. The test plots represented each of the following variables:

Cover types--

Manzanita (Arcotostaphylos sp.), light, medium, and heavy density

Chamise (Adenostoma sp.), light, medium, and heavy density

Scrub Oak (Quercus dumosa), light, medium, and heavy density

Coniferous (Pinus ponderosa), a seedling and sapling stand

Buckbrush or Buckthorn (Ceanothus sp.), a dense buckthorn field

Open terrain--

Grass covered

Litter covered (Primarily pine needles)

Dirt covered

Slope--

15 percent open and brush covered

30 percent open and brush covered

60 percent open and brush covered

Dummies were dropped into each of the test plots at two separate flying speeds: at zero, or hover, speed and at 5-10 miles per hour.

Because of the risk of damaging electronic controls in the dummy, the controls were removed from the dummy before the tests. To determine the maximum safe free fall distance for a human body, research results were obtained from tests conducted by the Aero Medical Laboratory, Wright Air Development Center, United States Air Force (10). These results indicated that 10 feet above the ground was the maximum safe jump height. All helijump tests were conducted within this height.

Results and Conclusions

The Helijump Suit

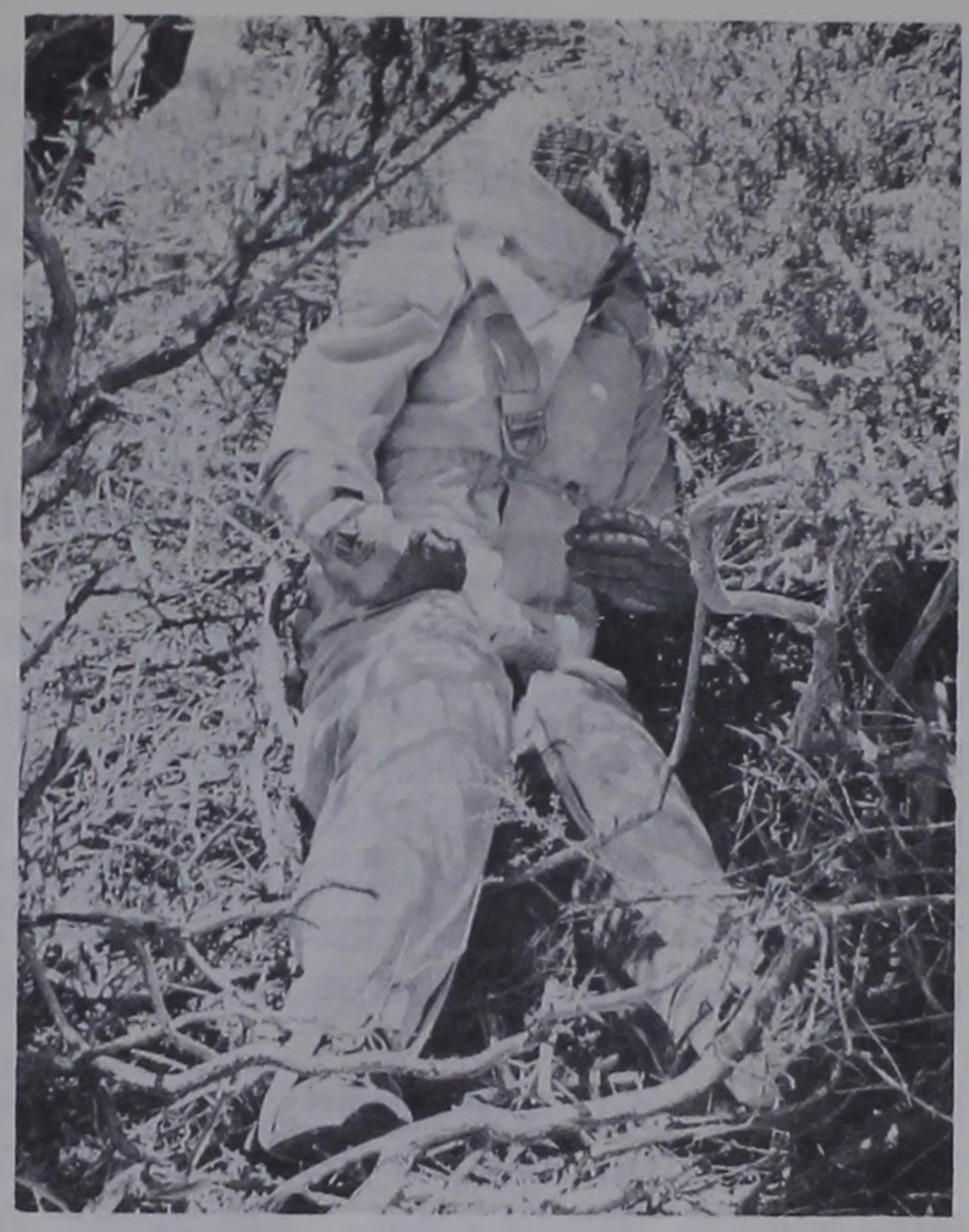
1. The felt padding on the helijump protective suit served two purposes; it was a shock absorber, but it was also an effective puncture-proofing material. In one instance, the felt padding furnished complete protection against a jagged piece of manzanita limb. Subsequent additions of felt padding to some areas of the helijump suit have made it much safer.

2. The fine mesh screen on the face mask is both necessary and effective. The dummy landed face down in fine brush and heavy litter on one jump without any indication of possible injury.

The felt padding in the helijump suit prevented a jagged piece of broken manzanita from penetrating through to the body.

The fine-mesh face mask completely protected the face when the dummy landed face down in fine brush and heavy litter.

A forward speed of 5-10 miles per hour helps the jumper settle naturally into the cushioning green limbs.



Flying Speeds

1. Zero flying speed, or a hover, is difficult to achieve or maintain, particularly when there is a wind.

2. When jumps were made into brush from flying speed of 5-10 miles per hour the slight forward speed helps the jumper settle naturally into the cushioning limbs.

3. A forward speed of 5-10 miles per hour over open ground aids the jumper in going into a simple roll with the direction of the ship. This observation was significant since a distinct hover cannot be depended upon.

4. Flying speeds over 10 miles per hour may prove dangerous in some situations. The speed would have a tendency to throw the jumper along the ground, rather than allow him to roll naturally. Possible injury could result from being thrown against rocks or heavy limbs.

Flying speeds over 10 miles per hour may tend to throw the jumper against heavy rocks or heavy limbs.

Cover Types

1. The average height of the helicopter skids above the tallest stems was 2 feet. Vegetation can be no taller than 8 feet to keep within the 10-foot jump height limit.

2. All three densities of manzanita--light, medium, and heavy--perforated the protective suit. In light and medium manzanita the perforations were caused by dead material of which there seemed to be an excessive amount. The green boughs in the light and medium densities were relatively resilient. In the heavy manzanita, the weight of the dummy sheared one of the heaviest brittle limbs. The jagged edge tore the suit, but the felt padding prevented a complete perforation. Slow motion movies later showed that as the dummy fell through the different cover types, the manzanita appeared as a stiffly vibrating picket fence while the other cover types bent as a wheatfield in a brisk wind.

3. Chamise, scrub oak, buckthorn, and coniferous reproduction stands under 10 feet in height proved to be resilient and shock-absorbing. Of these types, light to medium buckthorn and scrub oak patches offered the best jump cushion.

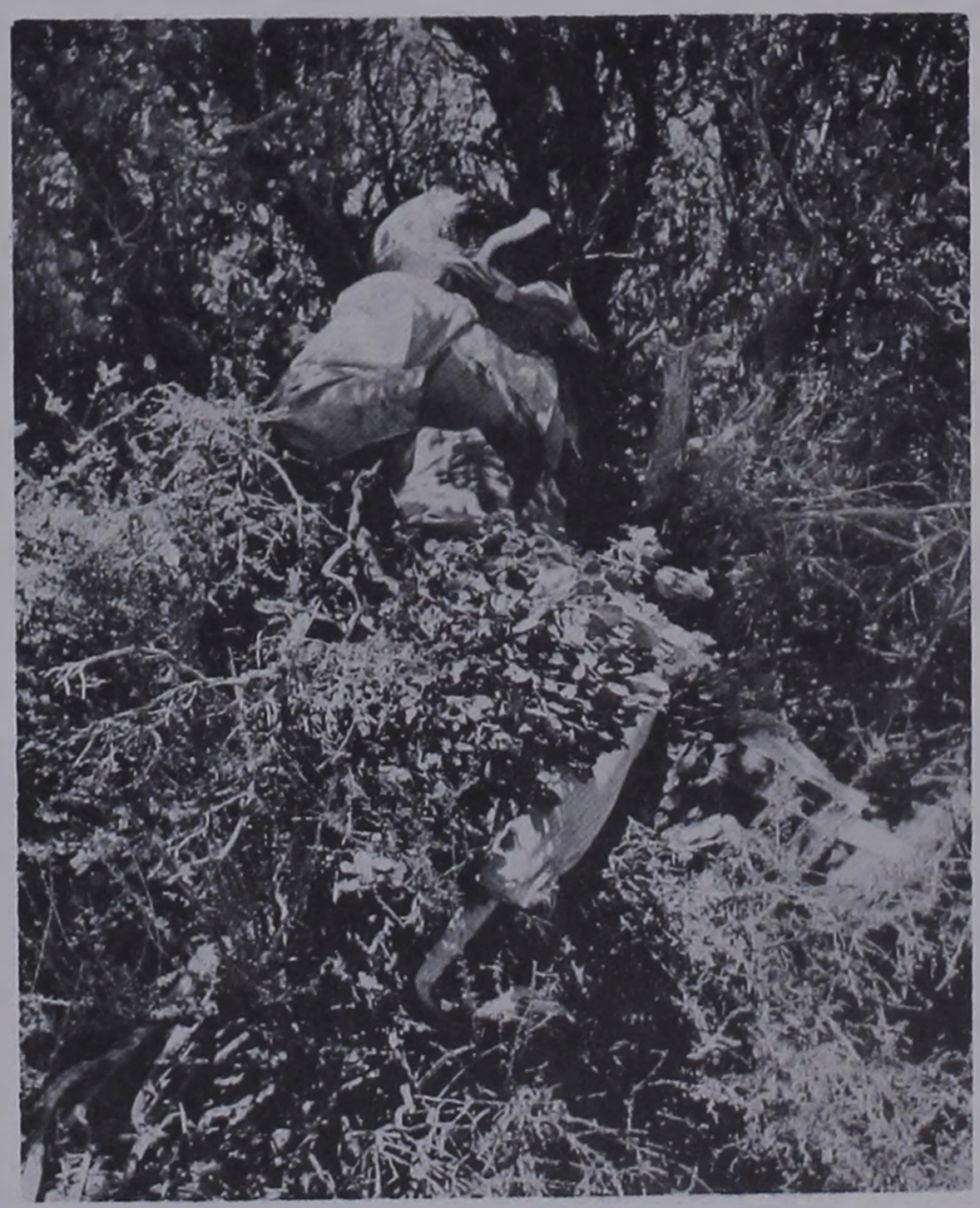
Light to medium buckthorn and scrub oak make good jump cushions.

4. The best cushioning effect in the deliquescent cover types was observed when the dummy was dropped to the outer edge of the individual brush clumps.

5. One patch of medium scrub oak contained an excessive amount of visible dead material. The green branches were very resilient under the dummy's weight. The dead limbs broke, producing sharp points. The brittle nature of dead material could be dangerous to the helijumper.

6. Three of the cover types tested--oak, chamise, and manzanita--were deliquescent species. Several times the dummy dropped into the middle of the brush clump feet first. A foot lodged in the stem junction and was held fast while the body fell away. A severe ankle sprain or break could have resulted.

7. Retrieving the dummy was difficult in the heavy oak and chamise stands and in buckthorn fields. A helijumper might have trouble freeing himself and departing from the jump spot in dense cover types.



A jumper might have trouble freeing himself and departing from the jump spot in dense cover types.

8. Tools dropped from the helicopter were hard to locate and retrieve in the dense cover types. Flagging the tools made them much easier to locate.

9. Dense cover, particularly buckthorn fields, may hide rocks or logs.

Open Ground

1. Grass-covered areas make good jump spots if the grass is not high enough to hide the logs or rocks.

2. Litter- and pine-needle-covered areas provided good jump spots.

3. Dirt surfaces were good if no large rocks were present. On one jump the dummy's foot struck a medium-sized rock and the entire leg collapsed unnaturally. A severe strain or sprain could have resulted.

Slopes

1. Several methods of helicopter approach to jump spots on slopes were tried. The safest method proved to be contouring the slope, with the jumper stepping out on the near-slope side.

2. The natural tendency of the dummy when landing on slopes was to fall backwards, or downhill, even though facing into the hill. When the dummy was placed in an exaggerated forward lean while landing, the tendency to fall over backwards was eliminated.

3. On open slopes less than 60 percent, the dummy fell forward, occasionally sliding a few feet downhill. On 60 percent slopes, however, nearly every jump resulted in the dummy sliding downhill a considerable distance.

4. On moderate slopes--15-30 percent, when the dummy was dropped between brush clumps, the clumps helped to check downhill sliding.

Clumps of vegetation on moderate slopes may keep the jumper from rolling.

5. Uneven ground on a 30 percent slope threw the dummy off balance when landing. Instead of falling naturally into the slope, the dummy twisted and plunged headlong down the hill.

6. A hidden rat's nest acted as a springboard during one jump into brush on a 60 percent slope. The dummy hit the nest and was catapulted down the hill.

7. Tools dropped into open slopes tended to roll downhill. Dropping them into brush eliminated the rolling.

The Helijump Procedure

1. The reaction of the dummy while landing in the open or in the vegetated areas was similar to the human body's natural reaction, without muscular compensation. During most jumps, particularly those from the moving helicopter, the dummy settled easily into the green limbs, or rolled easily to the open ground. The tests indicated that giving way to natural body reaction is safest.

2. Jumps in medium oak and heavy chamise occasionally caused branches to lodge in the armpit and the crotch area of the dummy. When the dummy's arms were folded across his lower chest, and his legs placed tightly together, the chance of limbs lodging in these regions seemed to be reduced.

3. During the jump into medium chamise, the dummy fell over the larger boughs when landing, causing the head to be snapped back. Tucking the chin and hunching the shoulders would help to prevent a similar happening under actual conditions. (The smokejumpers' program recommends chin tucking and shoulder hunching while making ground contact. (11)).

RECOMMENDATIONS

The Helijump Suit

Addition of felt padding to certain parts of the helijump protective suit was recommended to the Missoula Aerial Equipment Development Center. The additions are being included in all current suit models.

The Helijump--Picking the Jump Spot

1. Pick a spot out of the anticipated path of the fire.

2. The helicopter must be able to reduce speed to 10 miles per hour or less during the jump.

3. Maximum safe jump height is 10 feet.

4. Flag your tools before the drop so they may be easily located.

5. Pick a flat area if you can.

   a. Pick an open, bare area if possible, where you can see what is on the ground.

      (1) If it is grass, watch for hidden rocks or logs.

      (2) Avoid uneven ground, rocky areas or burns with sharp stubs.

   b. If you have to jump into vegetation--

      (1) Vegetation should be not taller than 8 feet (Helicopter skids will be 2 feet above the tallest stem).

      (2) Avoid all densities of manzanita.

      (3) Avoid any vegetation with a lot of visible dead material. Pick a green patch in which to jump.

      (4) Vegetation best suited for jumping includes--

      Scrub oak
      Chamise
      Buckbrush, or Buckthorn
      Coniferous reproduction

      Light to medium buckbrush and scrub oak make the best jump cushions.

      (a) Jump near the edge of light and medium buckbrush and scrub oak, otherwise you could become entangled.

      (b) Jump near the edge of deliquescent species. If you jump into the center of such species, a foot may lodge in the crotch. Branches are most supple at their ends.

(c) Remember that all dense vegetation could hide rocks or logs.

c. If you have to jump on a slope--

(1) Pick a slope under 60 percent

(2) Pick a slope where the helicopter can contour across the slope. The jumper must be on the uphill side.

(3) Pick an open slope, if possible, where you can see what is on the ground.

(4) Avoid broken hillsides and bluffs. If you have to jump on a slope with vegetation--

(a) Jump into safe cover type only.

(b) Be sure of your footing when you land. Watch for uneven ground, rocks, or other obstructions.

(c) On moderate slopes--15-30 percent jump between clumps of vegetation if possible. They will stop you from rolling.

(5) Drop your flagged tools into a brush clump, if possible, where they won't roll.

The Four-Pass Helijump Technique

IMPORTANT: Do not attempt a helijump unless:

a. You are trained and experienced in the technique.

b. The pilot is trained and experienced in the technique.

c. You are wearing the helijump protective suit with headgear and face mask, heavy gauntlet gloves, and high-top, sturdy boots.

1. High Level Reconnaissance Pass

The pilot and jumper will pick, in general, the safest jump area. Do not jump ahead of the fire. (See guidelines for picking the jump spot.)

2. Low Level Reconnaissance Pass

The pilot and jumper will pick the specific jump spot. Watch the fire. Know guidelines for picking a jump spot. Pilot may test flying stability.

3. Tool Drop Pass

Drop tools away from actual jump spot. Pilot may test ground effect and rotor clearance on this pass.

4. Jump Pass

During the approach to the jump spot:

a. At pilot's signal, jumper unfastens safety belt. Be sure belt is completely free.

b. At pilot's signal:

(1) Grip both sides of the open door firmly.

(2) Swing the right leg out to the skid. Plant foot securely against the skid near the gear leg.

(3) Swing left leg to skid and plant foot securely.

(4) Brace right leg snugly against skid gear leg. Brace right buttocks against body of the helicopter. Keep shoulders well back toward the body of the ship. The closer your weight is to the center of the gravity of the helicopter, the easier and safer the jump becomes.

(5) When in position and ready for the jump, wait for pilot's signal.

(6) At pilot's signal:

(a) Step off immediately without exerting undue backward pressure against the helicopter skid. Do not push off.

(b) After leaving skid, keep your legs together.

(c) Fold arms across lower chest, elbows snug against body. Tuck chin down to chest.

SUMMARY

THE HELIJUMP TECHNIQUE PICTURED

1. Before you jump--

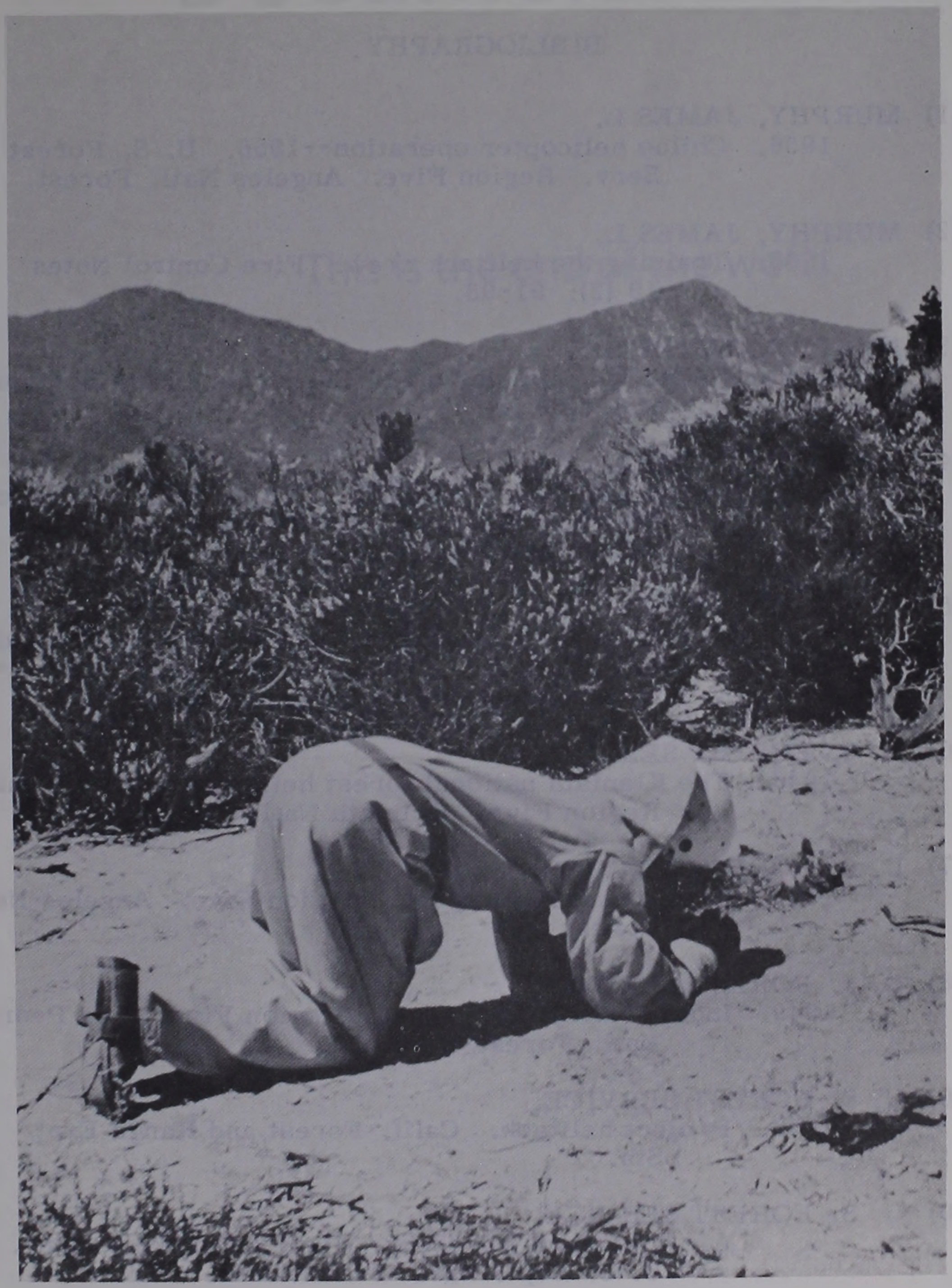
   - Be sure you are trained in the technique.
   - Be sure the pilot is trained in the technique.
   - Wear the helijump protective suit--with headgear, heavy gloves, and high sturdy boots.

2. At pilot's signal, grip both sides of the open door firmly, swing the right leg to the skid. Plant foot firmly against the skid gear leg. Swing left foot beside it.

3. Keep lower legs snug against skid gear leg. Lean buttocks against body of ship. The closer your weight is to the center of gravity of the helicopter, the easier and safer the jump becomes. Wait for pilot's signal to jump.

4. At pilot's signal, fold your arms across the lower chest, elbows snug at side, chin tucked. Keep your legs together. When you hit the ground, relax and roll.

5. Roll with the direction of flight of the ship. Keep your elbows snug at your side, your legs together, and your chin tucked.



6. Remain on the ground until the helicopter is safely away. Wave streamer to indicate to the pilot "all O.K.".

BIBLIOGRAPHY

(1) MURPHY, JAMES L.
1956. Chilao helicopter operation--1956. U. S. Forest Serv. Region Five. Angeles Natl. Forest.

(2) MURPHY, JAMES L.
1958. Training the helitack crew. Fire Control Notes 19 (2): 91-93.

(3) MURPHY, JAMES L.
1958. Helitack crews pay off in California. Fire Control Notes 19 (2): 94-96.

(4) MURPHY, JAMES L.
Initial attack by helicopter. Unpublished report to the supervisor. U. S. Forest Serv. Region Five. Angeles Natl. Forest.

(5) U. S. AIR FORCE.
C-124 escape procedures. Anthropology Section of the Biophysics Branch, Aeromedical Laboratory, Wright Air Development Center.

(6) U. S. FOREST SERVICE.
1946. The Klamath national forest helicopter experiment. Region Five. Klamath Natl. Forest.

(7) U. S. FOREST SERVICE.
1947. The Bryant fire report. Region Five. Angeles Natl. Forest.

(8) U. S. FOREST SERVICE.
1949. Indian valley fire report. Region Five. Los Padres Natl. Forest.

(9) U. S. FOREST SERVICE.
1956. Project helitack. Calif. Forest and Range Expt. Sta.

(10) U. S. FOREST SERVICE.
Air operations handbook. Part 2, Smokejumping. U. S. Dept. Agr. Forest Serv.

(11) WILSON, CARL C., and GERALD HAYES.
1954. Chilao helishot report. U. S. Forest Serv. Region Five. Angeles Natl. Forest.